AN EXPERIMENTAL STUDY IN THE USE OF COMPUTER-BASED INSTRUCTION TO TEACH AUTOMATED SPREADSHEET FUNCTIONS

THESIS

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AFIT/GLM/LSR/91S-24

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AFIT/GLM/LSR/91S-24

AN EXPERIMENTAL STUDY IN THE USE OF COMPUTER-BASED INSTRUCTION TO TEACH ELECTRONIC SPREADSHEET FUNCTIONS

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

Russell A. Greene

Captain, US Army

September 1991

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Abstract

Educational institutions at all levels are increasingly examining the advantages of computer-based instruction (CBI) to augment or replace conventional classroom learning environments. This research measures the effectiveness and efficiency of a CBI program in relation to the same course content delivered in a conventional classroom mode of an undergraduate course that teaches students the basic concepts and techniques of automated (electronic) spreadsheets. A CBI program was created to "mirror" the in-class instructional material of the course. The performance of the students who took the course by CBI was compared to the performance of the students who took the course in the conventional mode. The CBI course was found to be significantly more efficient while producing learning effects similar to the conventional mode of instruction. The students' prior experience and knowledge levels were offset by learning in either instructional mode. The initially "weaker" students were not identifiably weaker after completing the course by either method. Self-reported prior experience was an effective indicator of the students' actual pre-course knowledge level, but not an indicator of the students' post-course performance.

AN EXPERIMENTAL STUDY IN THE USE OF COMPUTER-BASED INSTRUCTION TO TEACH AUTOMATED SPREADSHEET FUNCTIONS

I. Introduction

General Issue

Computer-based instruction (CBI) effectiveness and efficiency have been studied extensively. Educational institutions at all levels are increasingly examining the advantages of CBI to augment or replace conventional classroom learning environments.

One of these institutions is the Air Force Institute of Technology (AFIT). "With technology changing almost daily, the need to keep education current while anticipating future needs is a demanding role for the Air Force Institute of Technology" (7:2). In its continuing commitment to education and technological superiority (7:iv), AFIT is investigating the potential benefits of computer-based instruction.

One potential candidate course for CBI is the School of Systems and Logistics' course QMGT 290, Introduction to AFIT Computer Systems. QMGT 290 is an undergraduate summer short term course that introduces students to the computer systems they will be using in their graduate program. An eight hour unit of QMGT 290 introduces students to the basic concepts and techniques of automated spreadsheets. Student performance in the spreadsheet unit is measured by a final spreadsheet assignment that is customarily graded on a satisfactory-unsatisfactory basis. The spreadsheet unit of QMGT 290 is currently taught using Quattro Pro™ spreadsheet software on IBM™ compatible computer systems. AFIT provides students with sufficient IBM compatible computer systems loaded with Quattro Pro software. In addition, many students own IBM compatible computers for home use.

Specific Problem

The specific problem of this research is summarized in the following research question: In one of AFIT's curriculi, what are the effectiveness and efficiency of learning from a computer-based instruction program in relation to the same course content delivered in a conventional classroom mode?

Research Objectives

The objectives of this research were to develop a computer-based instruction program to introduce fundamental automated spreadsheet functions and measure the program's effectiveness and efficiency in relation to the same course content delivered in the conventional classroom mode of the School of Systems and Logistics course QMGT 290.

Steps Taken to Address the Research Objectives

To address the research objectives, the following sub-objectives were met:

1. Develop a theoretical knowledge base on CBI effectiveness and efficiency, and examine the literature on CBI design, programming, and human-computer interface features.

2. Identify the course requirements of the spreadsheet unit of the School of Systems and Logistics course QMGT 290.

3. Determine an appropriate experimental design to use for this study.

4. Create and verify the content and operation of a CBI program that mirrors the course requirements of the spreadsheet unit of QMGT 290.

5. Conduct the CBI experiment.

6. Analyze the results, and state the findings of the experiment and the literature review.

Definition of Terms

Computer-Based Instruction. Computer-based instruction is an educational tool that uses computers, computer programming, and human computer interface techniques to aid or support the education or training of people (8:87). For the purpose of this study, the term "computer-based instruction" encompasses all of the terms shown in the second and third column of Table 1.

CBI programs can be placed under one of three major categories: automated drill and practice (4:34; 5:110; 15:104; 32:43), interactive tutorial programs (5:110; 9:104; 15:104; 18:529), and simulations (5: 110; 15:104; 18:529).

For this research, computer-based instruction is defined as a stand alone (no human instructor), interactive tutorial program.

Instructional Method Effectiveness. In this report, instructional method effectiveness is defined as a measurement of student achievement or understanding as demonstrated in a post-instruction assignment.

Instructional Method Efficiency. Instructional method efficiency is defined here as the amount of direct instructional time required to accomplish the course objectives. The efficiency of the traditional

TABLE 1

TERMS USED TO DESCRIBE THE COMPUTER'S INTERACTION WITH EDUCATION OR TRAINING

computer	-aided -assisted -augmented -based -extended -managed -mediated -monitored -related	training instruction learning teaching education

(11:295)

"in-class" instructional method is the amount of time the students spend in class to accomplish the course objectives. The efficiency of the computer-based method of instruction is the amount of time the students spend using the computer-based instruction program to accomplish the same course objectives as the in-class instruction.

Spreadsheet Functions. For this research, spreadsheet functions are concepts, techniques, or operations that are required for a basic operational knowledge and which allow a more effective and efficient use of the capabilities of an automated spreadsheet package.

Scope

The findings of this study are limited to AFIT graduate students taking the spreadsheet unit of the School of Systems and Logistics course QMGT 290 and are not intended to directly predict how computer-based instruction would function with other types of course material or student populations.

Organization of this Research Document

Chapter II of this document contains the methodology used to address the research sub-objectives previously outlined. Chapter III describes the research findings. Chapter IV provides conclusions and recommendations based on the research findings.

II. Methodology

Overview

This chapter describes the methodology used to answer the research objectives posed in Chapter I. Each sub-objective's methodology is addressed separately.

Sub-objective 1

Develop a theoretical knowledge base on CBI effectiveness and efficiency, and examine the literature on CBI course design, programming, and human-computer interface features.

CBI Effectiveness and Efficiency. A literature review of past CBI studies was conducted to provide the researcher a theoretical knowledge base on the effectiveness and efficiency of CBI. A summary of the applicable findings from the literature is provided in Chapter III.

CBI Course Design, Programming, and Human-Computer Interface Features. In order to create an efficient and effective CBI program, a knowledge of successful CBI design, programming and human-computer interface features was required. The features used in the creation of the CBI program for this research were identified through a literature review and are detailed in Chapter III.

Sub-objective 2

Identify the course requirements of the spreadsheet unit of the School of Systems and Logistics course QMGT 290.

This research sub-objective was necessary to identify the specific course requirements of the spreadsheet unit of QMGT 290, to ensure that the CBI program course material was a "mirror image" of the course material presented to the in-class students. This sub-objective was addressed through two sources: a survey of the QMGT 290 course director and instructors and course requirements identified during the previous offering of QMGT 290.

The QMGT 290 Course Director and Instructor Survey. A copy of the course director and instructor survey is provided at Appendix A. A personal interview survey was developed to solicit the specific course requirements of the spreadsheet unit of QMGT 290. The survey's contents were derived from an interview session with two experienced QMGT 290 instructors, and from the Quattro Pro User's Guide (25). The survey identified open-ended theoretical knowledge elements and mechanical knowledge elements that instructors believe are important to the course. Theoretical knowledge elements addressed concepts and techniques that the respondents felt were important to any spreadsheet usage, regardless of the internal capabilities of the particular spreadsheet package. Mechanical knowledge elements solicited techniques, functions, or operations that were directly related to the internal capabilities of the Quattro Pro spreadsheet package. The theoretical and mechanical knowledge element responses helped determine the specific course material that would be presented to the in-class students, and thus included in the CBI program.

A draft of the survey was presented to the QMGT 290 course director for recommendations and approval. During administration of the survey, the instructors who would be teaching QMGT 290 during the research period and the course director were asked to rate each survey element that they considered to be a QMGT 290 course requirement with a relative importance rating of "1." All elements receiving a unanimous rating of "1" were included as course requirements. Elements not receiving a unanimous rating of "1" were personally discussed with the instructors and course director to determine inclusion. Chapter III provides a list of the finalized course requirements. All of the finalized course requirements were incorporated into the computer-based instruction program.

The Previous QMGT 290 Course Offering. The course requirements from the previous offering of QMGT 290 were determined through an interview with an experienced QMGT 290 instructor. These requirements corroborated the requirements identified by the instructor/course director survey.

Sub-objective 3

Determine an appropriate experimental design to use for this study.

The Experimental Population. The population for the experiment was the students who were taking QMGT 290 during the research period.

The Experimental Design. Due to its simplicity, ease of adaptation to the current QMGT 290 instructional method, and the requirement to permit voluntary participation, a self-selected experimental group quasiexperimental design was used (10:126-127). Students who would take QMGT 290 during the research period were allowed to voluntarily participate in the experiment. Students volunteered to take the course by either the traditional in-class method of instruction or the computer-based method of instruction. The students who volunteered for the traditional in-class method of instruction became the "in-class" group. The students volunteering for the computer-based method of instruction became the "CBI" group. The students were further sub-grouped based on their responses on a survey questionnaire and their score on a pre-course spreadsheet knowledge test. Specifics on these sub-groupings are discussed later under Sub-objective 6. The relevant characteristics of the student groups are discussed in Chapter III. This quasiexperimental design allowed for measurement of the "main effect" as well as the "interaction effect" of the grouping variables (10:123).

Identification of Student Characteristics that Could Affect the Experimental Findings. A literature review of previously conducted CBI experiments and studies identified student characteristics that could potentially confound the experimental results. To identify potentially confounding characteristics of the students participating in this experiment, a closed-response, self-administered questionnaire was developed (10:218; 13:64). A draft of the survey questions was distributed to a panel of three experienced spreadsheet users, the QMGT 290 course director, and an AFIT faculty member not directly involved with QMGT 290 for face validation. The survey was modified based on the panel's recommendations.

The survey (referred to as the pre-QMGT 290 student survey for the remainder of this report) was administered to the incoming students who would take QMGT 290 to determine the following information: self-reported computer experience, self-reported spreadsheet experience, self-reported CBI experience, and pre-course spreadsheet knowledge.

The Instructional Method Effectiveness Measurement for the CBI Experiment. A tool was needed to measure the relative effectiveness of the computer-based instruction method compared to the in-class instruction method. As mentioned in Chapter I, the spreadsheet unit of

QMGT 290 traditionally used an end-of-course spreadsheet assignment as an evaluation instrument. The spreadsheet assignment was customarily graded on a "satisfactory-unsatisfactory" basis. To minimize disruption to the traditional evaluation method, the researcher chose to use this same evaluation to compare students' performance in the CBI and in-class groups. To transform the traditional evaluation scheme from a "satisfactory-unsatisfactory" rating to a scalar measurement instrument, an evaluation form was developed (Appendix B). Contents of the form were based on criteria identified by the literature review and criteria obtained from experienced QMGT 290 instructors. The evaluation form proposed that the instructors rate each student's spreadsheet assignment in the following areas: achievement of project goals, creativity, documentation, effective use of the spreadsheet's capabilities, and the spreadsheet's layout/organization. A draft of the evaluation form was presented to the instructors who would teach QMGT 290 for recommendations and weightings for the evaluation elements. The finalized evaluation form was presented to the QMGT 290 course director for approval. The finalized evaluation form consisted of five weighted elements, and a total score. The five assignment evaluation elements and their weightings are provided in Table 2.

The instructors agreed to rate the students on each evaluation element on a scale of 1 (low) to 5 (high). The raw score of 1 to 5 was multiplied by the element weight to obtain a final score for each evaluation element. The student's total score was obtained by adding the final scores from each assignment element. The analysis methods used on the assignment evaluation results are described under Sub-objective 6.

TABLE 2

ELEMENTS FROM THE QMGT 290 STUDENT EVALUATION FORM AND THE ASSOCIATED ELEMENT WEIGHTINGS

Evaluation Element	Element Weight
Achieved project goals	X 3
Creativity	X 1
Documentation (on/off disk)	X 1
Effective use of spreadsheet capabilities	X 2
Layout/Organization	X 2

The Instructional Method Efficiency Measurement for the Experiment. The information necessary to measure instructional method efficiency included the literature review of Sub-objective 1, attendance records of the students who volunteered to participate in the in-class group, and responses of the CBI student volunteers on a post-course survey. Findings of the literature review and the in-class attendance records are presented in Chapter III. The post-course survey of the CBI students (referred to as the post-QMGT 290 student survey for the reminder of this report) asked the students to log the amount of time they spent using the CBI program. A copy of the post-QMGT 290 student survey is provided at Appendix C. The analysis methodology of instructional method efficiency is addressed under Sub-objective 6.

Threats to the Experiment's Validity. Each of the eight threats to internal validity (10:115-117) was considered. Characteristics of the students that volunteered for the CBI and in-class groups were measured, and considered in the final analyses and conclusions. The experiment lasted only 14 days with no member attrition; thus mortality, historical, and long-term maturation effects were controlled. Inherent to the CBI group was the freedom to choose when, where, and how quickly to take the course material. This provided control over short-term maturation effects such as hunger, tiredness, or boredom (10:116). The in-class group attended traditionally structured classes, and therefore had reduced control over short-term maturation effects.

Potential bias of the subjective post-test evaluations was an instrumentation threat to validity. The effectiveness measurement instrument was the course director and instructor approved assignment evaluation form (described previously). The researcher relied on the QMGT 290 instructors to remain unbiased in their evaluations of student assignments. The differences between the instructors' evaluation ratings were considered in the final analyses and conclusions.

Availability of Computer Resources for the Experiment. The CBI program required that students have sufficient access to computer resources, specifically the computer hardware and software. Lack of sufficient resources could have had a detrimental effect on measurement of the CBI's effectiveness and efficiency. To determine the availability of computer resources for the typical School of Systems and Logistics student, a survey of students who had previously taken QMGT 290 was created. The survey asked the former students their opinions on the availability and adequacy of the School of Systems and Logistics' computer resources. The survey also sought information regarding the number of students that owned home computers before they took QMGT 290, and the number of students who used Quattro Pro for QMGT 290. The applicable survey results are summarized and analyzed in Chapter III.

Sub-objective 4

Create and verify the content and operation of a CBI program that mirrors the course requirements of the spreadsheet unit of QMGT 290.

Sub-objective 1 identified the relevant CBI design, programming, and human-computer interface features desirable in a computer-based instruction program. The specific course requirements for the spreadsheet unit of QMGT 290 were determined under Sub-objective 2. The next step was to incorporate each identified course requirement into a comprehensive and effective CBI program, using applicable CBI design, programming and human-computer interface features. Prototypes of the CBI program were presented to a panel of three spreadsheet novices, two experienced spreadsheet users, two previous QMGT 290 instructors, the QMGT 290 course director, and one AFIT faculty member not directly involved with QMGT 290 for content and operational verification. Recommendations from these sources were incorporated into the final CBI program. A floppy disk copy of the CBI is maintained at the AFIT School of Systems and Logistics/LSC, Wright-Patterson Air Force Base, Ohio.

Sub-objective 5

Conduct the CBI Experiment.

The CBI group received instruction from the computer-based instruction program only. Each CBI group member was assigned a package containing computer disks and the CBI program installation instructions. The CBI group members were released from the eight classroom hours of the spreadsheet portion of QMGT 290. The in-class group attended class in the traditional manner. Both groups were allowed to ask questions of the instructors. All CBI software related questions were relayed to the researcher. A log of these referrals is provided at Appendix D. Identical post-course assignments were given to the CBI and in-class groups. A copy of the assignment is provided at Appendix E. Both groups were allowed to ask questions of the course instructor to clarify assignment instructions. The experimental analysis techniques are described in Sub-objective 6.

Sub-objective 6

Analyze the results, and state the findings of the experiment and the literature review.

Selection of the Data Analysis Methods for the Experiment. The QMGT 290 instructors evaluated each of their in-class and CBI students' post-course assignments on the evaluation form previously described.

A Wilk-Shapiro test for normality (30:226-228) was performed on the pre-QMGT 290 student survey data, the pre-course spreadsheet knowledge test scores, and the post-course spreadsheet assignment performance scores. Based on the results of the Wilk-Shapiro test, the Spearman Rank Correlation and the Kruskal-Wallis test were chosen as effective nonparametric statistical analysis methods (21:965-969,980-985; 30:193-196).

Analysis Methods Used to Determine the Effects of Student Characteristics on the Experimental Outcomes

The students who would take QMGT 290 during the research period were surveyed prior to beginning the course with the pre-QMGT 290 student survey. The Likert scale question responses were normalized to a ten-point scale. For yes-no response questions, a "yes" response was given a score of ten, a "no" response was given a score of zero. Blank responses were not included in the data analysis. The scores were grouped by content into three measurement categories: self-reported spreadsheet experience, self-reported computer experience, and self-reported CBI experience. The scores were analyzed and compared in three student groups: the CBI group, the in-class group, and both groups combined. The responses to questions in each of the three measurement categories for each student group were rank-correlated with a pre-course spreadsheet knowledge test score, and the post-course spreadsheet assignment score. The question responses that had less than a 0.5 rank-correlation were extracted. The remaining question responses were combined to form a composite for each measurement category within each student group. Table 3 lists the composites for each measurement category by student group. Note that none of the self-rated CBI question scores had a correlation of over 0.5 with the pre or post-course performance test scores.

TABLE 3

QUESTIONS FROM THE PRE-QMGT 290 STUDENT SURVEY THAT WERE RETAINED AND BECAME COMPOSITES FOR THE MEASUREMENT CATEGORIES

	Student Groups		
Measurement Category	Combined Groups	CBI Group	In-class Group
Spreadsheet Experience:	III 1,8,9 10	III 8,9,10	III 1,7,8,9,10
Computer Experience:	II 1,8,9,13	II 7,8,13	II 7,8,9,13
CBI Experience:	none	none	none

(NOTE: The roman numerals II and III represent sections II and III of the pre-QMGT 290 student survey.)

The composites from each student group were rank-correlated with the pre-course test and post-course assignment scores in the following ways:

- self-rated spreadsheet experience to pre-course spreadsheet knowledge test performance

- self-rated computer experience to pre-course spreadsheet knowledge test performance

- self-rated spreadsheet experience to post-course spreadsheet assignment performance

- self-rated computer experience to post-course spreadsheet assignment performance

The findings and analysis of the composite correlations are presented in Chapter III.

Analysis Method Used to Determine Instructional Method Effectiveness. The QMGT 290 instructors evaluated each student's post-course spreadsheet assignment on the assignment evaluation form previously described. The students were rated from 1 (low) to 5 (high) on each weighted evaluation element. The rating for each evaluation element was multiplied by the evaluation element's weight to determine the evaluation element's final score. The final scores from each evaluation element were summed to arrive at a total score for each student. A total score mean was calculated for the students in the CBI group and the students in the in-class group students. A median test (30:197-199) was conducted on the total score means to determine if the total score mean of the CBI group was different from the total score mean of the in-class group. A Kruskal-Wallis test was then conducted to see if the difference in the means was statistically significant. The CBI and in-class groups were also compared on the final scores for each of the evaluation elements.

To determine if differences between the instructors' ratings were meaningful, a separate Kruskal-Wallis test was performed on the data from each instructor.

Analysis Method Used to Determine Instructional Method Efficiency. Two methods were employed to determine instructional method efficiency. The first method was a literature review of past CBI experiments and studies. Findings of the literature review are presented in Chapter III.

A second indicator of instructional method efficiency was results of the previously mentioned post-QMGT 290 student survey (Appendix C). The survey asked the students in the CBI group to log the amount of time they spent using the CBI program. The mean time was calculated and compared to the amount of direct instructional time the in-class students received.

Analysis Method Used to Determine Student Attitudes and Opinions.

Student attitudes and opinions were studied through a literature review, and through responses of the CBI students on the post-QMGT 290 student survey (Appendix C). The survey was administered to the students in the CBI group after they had completed the CBI course and received their final score on the post-course assignment. The survey asked the CBI students' to rate (on a 1 to 7 Likert scale) their feelings about the CBI program they had completed in the following areas: program effectiveness, ease of use, the author's writing style, and value of the program in preparing them for the post-course assignment. The students were next asked to philosophically rate their feelings about CBI as a learning tool. The students were also asked if other courses at AFIT should be taught by the CBI method, and what type of computer user they would recommend take the CBI course that they completed.

The Likert scale responses were normalized to a ten-point scale, with 1 being at the negative end of the scale. The normalized mean score from each question was calculated and used as an indicator of the CBI students' attitudes and opinions on the particular question area. No attempt was made to compare the CBI students' attitudes or opinions to the attitudes or opinions of the in-class group.

III. Findings and Results

Chapter Overview

This chapter describes findings of the research sub-objectives described in Chapter II. The findings of each sub-objective are addressed separately. This chapter concludes with a review of the major findings.

Sub-objective 1

Develop a theoretical knowledge base on CBI effectiveness and efficiency, and examine the literature on CBI course design, programming, and human-computer interface features.

Literature Review Findings on Ways to Measure CBI Effectiveness and Efficiency. The literature included previously conducted CBI experiments, studies, and meta-analyses. The reviewed articles used CBI effectiveness and efficiency "measures" to assess the relative effectiveness and efficiency of the computer-based method of instruction. The measures that the literature identified as most important included student achievement, student attitudes, course completion statistics, time and resource efficiency, and the correlations between student achievement and the following: computer experience, subject matter knowledge, disadvantaged students, personality type, and grade level (5:112-114; 18:532-537; 19:24-25; 20:82).

Table 4 lists the measures used in this research to assess the relative effectiveness and efficiency of the CBI method. Since all students were required to complete the course, course completion statistics were not useful. Resource efficiency measurements were beyond the scope of this research. The students were all masters degree candidates, none of whom were disadvantaged. Determination of personality types was beyond the scope of this research

TABLE 4

MEASURES USED IN THIS RESEARCH TO ASSESS THE RELATIVE EFFECTIVENESS AND EFFICIENCY OF THE CBI METHOD

Instructional method time efficiency
Student achievement
Correlation between student achievement and self-reported prior spreadsheet experience
Correlation between student achievement and self-reported prior computer experience
Correlation between student achievement and prior subject matter (spreadsheet) knowledge
Students' self-reported post-course attitudes

Literature Review Findings on the Effectiveness and Efficiency of CBI. The literature review findings on the effectiveness and efficiency of computer-based instruction are addressed under Sub-objective 6, along with the findings of this research.

Literature Review Findings on CBI Course Design and Programming. Computer-based instruction in and of itself does not guarantee quality instruction. Quality lies in the content and design of the program that takes advantage of the medium's potential for interactivity (17:17). Quality CBI can be developed by combining current technology with sound educational theory (1:192). The following paragraphs outline the literature review findings on designing and programming CBI courses, concluding with a section on specific guidelines used in the creation of a CBI program for this research.

General CBI Program Design Considerations. CBI program design includes programming techniques, styles, approaches, and lesson sequences. An effective approach to the issues of CBI program design is the "user-centered approach" (23:20). In this approach, the students' capabilities, the course tasks and goals, and information requirements are considered early in the process of course design (23:20).

CBI Program Style. To a certain extent, personal instruction style can be reflected in the tone of the CBI lesson. The author must choose the persona or personality the CBI presents to the student. Many authors choose an "invisible" persona, while others employ persona characterized by humor, enthusiasm, or concern (27:64). The author's task is to choose the persona that is appropriate for the lesson material, and that appeals to the students in such a way as to enhance rather than distract from the learning.

Another element of computer-based instruction program style is the use of special effects. Special effects can add emphasis, capture, and control the students' attention through highlighting, delays, special characters, graphic displays, animation, or scrolling text (27:64). The task of the CBI author is to ensure special effects enhance, not distract from, the CBI lesson.

CBI Lesson Approaches. CBI lessons are simply tools or frameworks for topic presentation. The author is responsible to ensure appropriate content and order of presentation. CBI has the advantage of topic customization, but requires detailed early and careful preparation (15:105).

Computer-based instruction lesson approaches include gaming, drill and practice, simulation, tutorial, and inductive versus deductive course material presentation (27:58-60). A computer lesson using a single methodology is unlikely to be successful in and of itself. A CBI program should combine lesson approach methods, such as a tutorial followed by drill, then a test. Multiple lesson approach methods, however, increase program length and complexity beyond the scope of a single lesson. A CBI program will normally be more successful if it is based on a series of combined methodology lessons (1:147).

Gaming Lesson Approach. "The advantage of instructional games is that they are usually more engaging than other forms of instruction, and the students persist in using them longer" (1:150). Gaming is especially suitable for lower grade levels but can be effective with adults as well (27:58).

Drill and Practice Lesson Approach. The drill and practice lesson approach includes instruction and exercise on a certain topic, which is usually presented in a simple question and answer format. The computer provides practice and drills on a topic, and provides the students immediate feedback on their performance (5:110). At the conclusion of the question series, the computer evaluates the student's performance (15:104). Drill and practice is normally used for basic rather than advanced material (27:60).

Simulation Lesson Approach. An advantage of simulation is its ability to imitate and simplify reality (1:150). Simulation can model complex systems which cannot be moved into the classroom (5:110). The computer can store great amounts of material in a simulation scenario, presenting a series of problems to the student. Simulations support the comprehension of interrelated facts through interactive decision making (15:105). Simulations involving many students are sometimes referred to as gaming (15:104).

Tutorial Lesson Approach. A CBI tutorial is a complete educational process that contains a series of smaller frame-by-frame presentations of a larger topic (15:104: 27:60). The frames are presented in fixed, though flexible, format allowing students to review or branch based on their progress (5:110; 15:104). The tutorial's strength lies in the presentation of text and graphics enhanced by short question and answer evaluation sessions and step-by-step explanations (15:104-105).

Inductive Versus Deductive Lesson Approaches. The author chooses to design the CBI lesson flow from examples to rules (inductive) or from rules to examples (deductive). Inductive lesson design is good for discovery type lessons, while deductive is generally better for lecture type information (2:3-9,47-53; 27:60).

Lesson Design Sequencing. Three major CBI lesson design sequencing strategies are linear, branching, and changing (27:57).

Linear Sequencing. Linear sequencing is the simplest and most commonly used design. In linear sequencing, all students receive the same material in the same sequence. Strictly linear sequencing does not take full advantage of CBI flexibility and can cause boredom in students (27:57).

Branching. In a branching lesson sequence, students can be directed to alternate routes, including feedback loops, material review, or additional practice based on test performance or the student's request. Branching is better for more complex subjects, and is more adaptable to student and instructor styles than linear sequencing (27:57-58).

Changing. Changing CBI lessons can vary with each use. Often changing CBI is generative, consisting of banks of questions or assignments which are randomly or systematically presented to the student. Changing CBI can also be adaptive, learning from the students who use them, and improving future instructional material (27:58).

Literature Review Findings on Human-Computer Interface Features. Human-computer interface features are methods through which the computer and student communicate and interact.

Hardware Interface. The computer can convey information to the student through voice synthesis, equipment panel mock-ups, a computer monitor, and others. The student can communicate with the computer using a joystick, light pen, mouse, keyboard, track ball, equipment mockup, touch-screen, and voice recognition (29:7).

The computer resources available for this research required keyboard input, and computer monitor visual output. Although no specific instruction was provided, the students could also use a mouse input device.

Software Interface Design. Papazain found that there is currently no widely accepted model of software interface design. He stated that many of the interface guidelines found in literature contradict one another. There is little consensus concerning criteria on what constitutes a "good" interface design. The only thing on which most human factors experts agree is that to have a good design, the specific purpose of the CBI program must be known up front. Software interface design is a process that is difficult to describe precisely enough to be useful to people doing specific work, and general enough to remain relevant over time, or for more than one specific application

(23:2-3,20). Moore agreed that no clear interface design standards exist. He found that many studies have been conducted and much written with respect to user interface guidelines, but there remain no well-defined standard and a fair amount of inconsistency from source to source (22:14).

These research findings underscore the difficulty in determining specific CBI interface design guidelines that are universally acceptable or applicable.

The CBI Program Design Used for This Research. Predicted characteristics of the students who were going to take QMGT 290 during the research period were collected through a survey of students who had formerly taken QMGT 290. The predicted characteristics allowed a "user centered" programming approach early in the CBI design process. The CBI program used an "invisible" persona to enhance learning by focusing the students' attention on the course material rather than the delivery method. Special effects were limited to highlighting and graphic displays. More elaborate special effects had the undesirable potential to draw the students' attention away from the course material, and towards the special effect itself.

The CBI lesson approach included a combination of tutorial and drill and practice methodologies presented in a deductive manner. The course material was well-suited for frame-by-frame, modularized presentation. The course material was presented in three modules, each containing three lessons. Each lesson included 10 to 15 frames of course material, followed by a five question drill-and-practice test. Students could take the tests at any time. The program provided instant feedback after each test question, and allowed the student to immediately review relevant course material or to continue with the test. Scores were automatically maintained and presented at the end of each test, and upon request. The student had the option to accept the final score or retake all or part of the test before or after reviewing the lesson material. The program's modularity allowed for ease of updating, modifying, or adding additional course material.

The CBI program used a branching lesson sequence, containing feedback loops, material review, and additional practice. The students had full control over the program and could take lessons in the recommended sequence or in any sequence they chose. They could stop, start, or review any lesson at any time.

Examples of the CBI program's lesson frames and test frames are provided in Appendices F and G. A computer floppy disk copy of the CBI program is currently maintained the AFIT School of Systems and Logistics/LSC, Wright-Patterson Air Force Base, Ohio.

A Discussion of the Specific CBI Design Guidelines Used in the CBI Program Developed for This Research. Authors of computer-based instruction design have various and sometimes incompatible recommendations. One technical report reviewed 63 computer-based instruction related articles, and generalized CBI design into 57 "CBI Guidelines." Of the 57 guidelines, 38 had some disagreement between authors, and 8 had conflicting research findings. Forty-four guidelines had insufficient research, and in only three cases was there agreement between authors and sufficient supporting research (31:37-41). Many articles presented lists of generalized CBI guidelines, principles, strategies, considerations, or attributes (3:1-13; 14:3-5,16-20; 22:14-36; 27:47-57; 28: 286-290; 31:37-40). This report refers to the identified principles, strategies, considerations, and attributes as CBI guidelines. The guidelines considered applicable to this research are presented in the following broad categories: general guidelines, screen design guidelines, menu system guidelines, on-screen text and graphics guidelines, feedback guidelines, and input and output guidelines

General Guidelines. Following is a list of general design guidelines that were followed in the CBI program for this research:

1) Make the CBI simple, easy to learn, easy to use, and easy to remember (22:14; 27:286).

2) Design the CBI to be reliable, standardized, and consistent throughout (14:3; 22:14; 28:286).

3) Make the CBI courteous and helpful (22:14).

4) Allow the students to control the CBI, including rate of presentation (14:4,18; 22:15).

5) Make the CBI adaptable to the students' expertise/level of knowledge (14:4; 22:15; 28:286).

6) Minimize the memory requirements on the students (14:3; 28:286).

7) Define the instructional objectives (27:47).

8) Present questions to the students (31:37).

9) Keep the total session or lesson time within the students' attention span (14:16).

10) Ensure that symbols have the same meanings at all times (14:17).

11) Provide the students a page-back capability to review previous material (14:18).

12) Allow the students to easily exit lessons, return to the menu, and exit the program (14:18).

13) Create the program in a modular format (14:18).

Screen Design Guidelines. The computer monitor remains the primary means for the computer to convey information to the student

(29:7). The CBI program for this research allowed students to interactively choose or change screen colors based on their personal preference. Following is a list of other identified screen design features that were used in the CBI program:

1) Use a consistent display format on the screens. Keep the location of information categories (e.g. titles, prompt lines, error messages, help messages, menus, etc.) consistent within the program. (14:17; 28:290).

2) Center information on the screen (28:290).

3) Use color, boxing, and highlighting rather than blinking to focus attention on important segments of information (14:16; 17:131; 22:36).

4) Highlight no more than ten percent of the screen at one time (14:16).

5) Have only one logically connected thought per screen (28:290).

6) Use titles instead of numbers to identify screens (14:19).

Menus Systems Guidelines. Menus are recommended for occasional and novice users (22:22). Menus are an important feature in making computer-based instruction user-friendly. They are the "most powerful CUIPs (computer user interface programs) available," and should be laden with user-friendly features (3:10). Following is a list of the identified CBI menu features used in the CBI program for this research:

1) Ensure that menus are easy to learn and use (22:36). Keep the layout simple and consistent (3:12). Make the selections self-explanatory, explicit, and brief (28:291).

2) Have three to nine choices on each main and submenu (14:16).

3) Allow the student to make a menu selection with upper or lower case entries (28:291).

4) Prevent anything from happening, (other than feedback) if an invalid key is pressed (3:12).

5) Provide the students a status report if a menu operation takes time (3:12).

6) List the menu choices in a logical order with the most frequently used selections at the top (28:291).

7) List menu options by number rather than letter, where order of lessons is important (14:19).

8) Limit routing menus to a maximum of three levels (14:19).

On-Screen Text and Graphics Guidelines. For this study, the computer communicated to the student through on-screen text and graphics. The following list of desirable on-screen text and graphics features was considered in designing the CBI program:

1) Limit the lines of text per screen, preferably to no more than seven (14:16).

2) Use simple syntax in the active voice (14:16).

3) Justify text to the left, numbers to the right, and align decimal points (28:291).

4) Present long lists in some logical order such as alphabetical, chronological, or numerical (28:291).

5) Use consistent wording convention throughout the program.

6) Present critical information at the beginning of a message or centered on the screen (14:17).

7) Have no more than three or four consecutive text screens without student interactivity (14:16).

8) Allow no more than five seconds for text and graphics to fill the screen (14:20).

9) Do not use words unique to the computer field (22:22).

Feedback Guidelines. "Research indicates that feedback which provides information, not simply immediate feedback, is the key to performance change: . . . informational feedback helps the student locate the error and construct an alternative response" (14:5). Most authors agree that CBI programs should provide the student with specific, informative feedback (1:148; 14:5.20; 22:15; 28:286; 31:37). Following is a list of feedback features used in the CBI program:

1) Do not present novel or entertaining feedback for errors (31:38).

2) Ensure feedback response times are prompt (22:14,15).

3) Keep feedback delay constant rather than variable (14:17).

4) Provide periodic feedback indicating normal operating status if the student must stand by (14:20).

5) Track response patterns and provide feedback on areas where the student needs remediation (14:20).

6) Distinguish feedback from other text through use of highlighting techniques (14:20).

7) Provide students a performance score (14:20).

8) Pause after feedback to allow time for consolidation of the newly acquired material (14:20).

Input-Output Guidelines. Input and output guidelines include the methods and conventions used by the student and the computer to effectively and efficiently communicate. The following input-output considerations were applied to the CBI program for this research:

1) Ensure presentation of output information and required student input are compatible. Require a minimum of cognitive processing to understand output and to know what input to provide (14:4).

2) Conform input and output to popular stereotypes (red = stop, green = go) (14:5,19).

3) Allow students to correct input through reentry (22:15).

4) Do not use multi/special function input keys other the ESC key (22:36).

5) Use consistent displays, question formats, and input/output requirements (14:17; 22:36).

6) Allow the students to correct and recover from input errors without disrupting the lesson sequence (14:18).

7) Require students to respond with codes only when necessary. Allow students to type in the first letter of a command rather than a code ("y" = yes instead of "1"= yes) (14:19).

8) Give the students more than one chance to answer (14:20).

9) Allow the students to interact frequently (1:148).

The summarized literature review findings on CBI course design, programming, and human-computer interface features were used along with the QMGT 290 course requirements (addressed next under Sub-objective 2) to create the Quattro Pro CBI program for this research.

Sub-objective 2

Identify the course requirements of the spreadsheet unit of the Sschool of Systems and Logistics course QMGT 290.

As mentioned in Chapter II, this research sub-objective was addressed through a survey of the QMGT 290 course director and instructors. The survey interviews identified the theoretical knowledge and mechanical knowledge elements, listed in Table 5, as the spreadsheet unit course requirements for QMGT 290. All of the identified requirements were included in the computer-based instruction program.

Sub-objective 3

Determine an appropriate experimental design to use for this study.

Literature Review Findings on Experimental Design. "There was virtually no evidence to suggest the existence of a relationship between experimental design features and study outcomes" (4:3). Kulik agreed that the features of the CBI studies and experiments were not related to outcomes (18:538; 19:25). Reduced experimental design bias, however, enhances the believability of CBI research findings. The Kulik

TABLE 5

THE SPREADSHEET UNIT OF QMGT 290 COURSE REQUIREMENTS THAT WERE IDENTIFIED THROUGH A SURVEY OF THE COURSE DIRECTOR AND INSTRUCTORS

Theoretical Knowledge Concepts:

automatic recalculation
consistency
data backup
documentation
logical spreadsheet design
spreadsheet uses/applications

Mechanical Knowledge Concepts:

basic math functions
- add, divide, multiply, subtract

cell blocks
- copy blocks, erase blocks

cells
- absolute vs. relative referencing, copy, enter data, erase

columns
- change/set width, delete, insert

editing
- edit cell data

files
- call up an existing file, change directory, open a new file, retrieve an existing file (replace current), save a file

graphs
- add text, choose type, create, customize series, modify X and Y axes, name, print, specify series, view

other operations
- basic @ functions, create and enter formulas, exit spreadsheet, use the pull-down menus

print
- print spreadsheet, set print block

rows
- delete, insert

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secondary school meta-analysis credited stronger CBI experiment effectiveness results in more current experiments to "more appropriate use" of CBI technology rather than improved design features (19:25).

The Kulik college level meta-analysis found the only variable in experimental design affecting study outcome was the use of the same instructor for the CBI and in-class course. The studies which used different instructors for computer based and in-class sections of a course had more clear cut examination differences favoring the CBI sections. The studies which used a single instructor for both classes produced differences that were less pronounced. The CBI development requirements of outlining objectives, constructing lessons, and preparing evaluation materials may improve the instructors' conventional teaching assignments (18:539).

The CBI program for this study was designed and written by the researcher. The instructors were involved in the CBI design process only to the extent of identifying course requirements.

Selection of the Experimental Design for This Research. As mentioned in Chapter II, a self-selected experimental group, quasiexperiment design was used due to that design's simplicity, ease of adaptation to the current QMGT 290 instructional method, and the course director's requirement that the students' participation in the experiment be voluntary.

Sub-objective 4

Create and verify the content and operation of a CBI program that mirrors the course requirements of the spreadsheet unit of QMGT 290.

Determining the Feasibility of Testing a CBI Program at AFIT School of Systems and Logistics. Prior to arrival of the students who would take QMGT 290, a survey of students who had taken the previous QMGT 290 course offering was completed. A copy of the survey is provided in Appendix H. Of the 135 surveys distributed, 89 were completed and returned; a 66 percent response rate. A complete list of the survey findings is provided in Appendix I. Table 6 outlines the survey findings that helped answer the following questions that are related to the feasibility of implementing a CBI program for the spreadsheet unit of QMGT 290:

1) Are the computer resources provided by the AFIT School of Systems and Logistics sufficient to implement a CBI program?

2) How many QMGT 290 students will have home computers available for use in QMGT 290?

3) Is Quattro Pro software sufficiently available for the QMGT 290 students?

4) Will the number of students who volunteer to participate in the CBI experiment be sufficient to justify a self-selected quasi-experiment design?

The data shows that 75 percent of the respondents used a home computer for QMGT 290. This finding, combined with the finding that 69 percent of the students felt that the AFIT School of Systems and Logistics personal computers were sufficient, indicates that sufficient computer hardware resources should be available to conduct a CBI course.

The finding that 88 percent of the students used Quattro Pro for QMGT 290 (although other commercial spreadsheet packages were permitted), the fact that the QMGT 290 course director chose Quattro Pro as the in-class spreadsheet software, and the fact that Quattro Pro would be available on the School of Systems and Logistics personal computers, support the choice of Quattro Pro as the CBI program software.

The finding that 32 percent of the students who formerly took QMGT 290 would have volunteered to take the course by CBI indicated that

TABLE 6

RESULTS OF THE FORMER QMGT 290 STUDENT SURVEY

	Number	Percentage
Used home computer for QMGT 290	67	75%
Felt AFIT School of Systems and Logistics personal computers are sufficient	61	69%
Used Quattro Pro for QMGT 290	78	88%
Would prefer to take QMGT 290 by the CBI method	28	32%

sufficient numbers of the students who would take QMGT 290 should volunteer for the CBI experiment. Knowing that 118 of the incoming students were eligible for the CBI course, it was predicted that approximately one third, or about 39 students would volunteer. In actuality, 46 of the eligible incoming students volunteered to take the spreadsheet portion of QMGT 290 by the CBI method.

Creation and Verification of the CBI Program. Sub-objective 1 identified the relevant CBI design, programming, and human-computer interface features desirable in a computer-based instruction program. The specific course requirements for the spreadsheet unit of QMGT 290 were determined under Sub-objective 2. Each course requirement was incorporated into Quattro Pro CBI program, using the design, programming, and human-computer interface features identified by the literature review. As mentioned in Chapter II, prototypes of the CBI program were presented to a panel of three spreadsheet novices, two experienced spreadsheet users, two previous QMGT 290 instructors, the QMGT 290 course director, and one AFIT faculty member not directly involved with QMGT 290 for content and operational verification. A floppy disk copy of the CBI program is maintained at the AFIT School of Systems and Logistics/LSC, Wright-Patterson Air Force Base, Ohio.

Sub-objective 5

Conduct the CBI experiment.

Each CBI group student was assigned a package containing computer disks and the CBI program installation instructions. The CBI group students were released from the eight classroom hours of the spreadsheet portion of QMGT 290. The in-class group students attended class in the traditional manner. Both groups were allowed to ask questions of the instructors during the course. All CBI software related questions were relayed to the researcher, a log of which is provided at Appendix D. Identical post-course assignments were given to the CBI and in-class groups. A copy of the assignment is provided at Appendix E. Both groups were allowed to ask questions of the course instructor to clarify the assignment instructions. The QMGT 290 instructors evaluated their respective students' assignments. Analysis and findings from the experiment are provided under Sub-objective 6.

Sub-objective 6

Analyze the results, and state the findings of the experiment.

Selection of the Data Analysis Method for the Experiment. As stated in Chapter II, a Wilk-Shapiro test for normality (30:226-228) was performed on the survey data from the pre-QMGT 290 student survey (a survey of the students who would take QMGT 290 during the research period), the pre-course test scores, and the post-course assignment scores. The data were not normally distributed and thus did not meet the assumptions required for parametric statistics. The pre-QMGT 290 survey data was at the ordinal level; thus the median was the appropriate measure of centrality (10:88-91). The Spearman Rank Correlation and the Kruskal-Wallis test were chosen as effective nonparametric statistical analysis methods (21:965-969,980-985; 30:193-196).

Presentation of Findings. The remainder of this chapter presents the relevant findings of this research. The literature review findings in each subject area are presented first, followed immediately by the findings from this research. The chapter concludes with a review of the major findings.

Student Characteristics That Could Confound the Experimental Findings on Instructional Method Effectiveness.

Findings from the Literature. Although not always in agreement, the reviewed literature indicated that student characteristics such as age, previous education, and computer experience may have an influence on CBI effectiveness (20:81). Erwin found that students' scholastic ability and computer attitude influenced the success of CBI (12:221-233). Student personality types can also affect CBI effectiveness (16:20). Some studies found that CBI achieved the best results with low ability students (5:112), while other studies found CBI to be more effective with students of high ability level and with disadvantaged students (4:37-38). The Roblyer meta-analysis found no statistically significant evidence to support the relationship between student characteristics and CBI effectiveness (26:54). Kulik agreed that there is at best only a small correlation between student aptitude and the effectiveness of CBI (18:536).

Findings from This Research. For this study, all students possessed at least a BS college degree. Selection for attendance at AFIT implied a proven scholastic ability level. The most significant confounding variables of the students participating in this research were past computer and subject matter (spreadsheet) experience. These variables were measured on a survey of the students who would be taking QMGT 290 during the research period (the pre-QMGT 290 survey). A copy of the survey is provided at Appendix J.

The pre-QMGT 290 survey was administered on May 23, 1991. Of the 118 qualified respondents, 108 returned a completed survey, for a 92 percent response rate. One hundred and three of the 108 students that returned a survey elected to voluntarily participate in the experiment: 46 for the CBI group, and 57 for the in-class group. The 15 students who did not return a survey or volunteer to participate in the experiment attended class in the traditional method, but were not represented in any of the data for this study. General characteristics of the CBI and in-class student groups are provided in Appendix K.

Sub-objective 6, in Chapter II, described the method used to analyze the effects of the identified student characteristics on the experiment. The results of the composite correlations are provided in Table 7.

Both (self-reported) prior spreadsheet experience and prior computer experience were positively correlated with pre-course spreadsheet knowledge. There was no substantial correlation between prior spreadsheet or computer experience and performance on the post-course assignment.

TABLE 7

RESULTS OF THE COMPOSITE CORRELATIONS OF THE MEASUREMENT CATEGORIES (STUDENT CHARACTERISTICS) TO THE PRE-COURSE SPREADSHEET KNOWLEDGE TEST SCORES AND THE POST-COURSE ASSIGNMENT SCORES

	Student Groups		
	Combined Groups	CBI Group	In-class Group
	Spreadsh./Comp. Experience	Spreadsh./Comp. Experience	Spreadsh./Comp. Experience
Pre-course knowledge test:	.60 /.61	.61 /.61	.58 /.59
Post-course assignment:	.10 /.29	.16 /.37	.00 /.11

Finding 1. Both (self-reported) prior spreadsheet experience and prior computer experience were effective indicators of pre-course subject matter knowledge for both the CBI and in-class groups.

Finding 2. Neither (self-reported) prior spreadsheet experience or prior computer experience were good indicators of performance on the post-course assignment for students in either group.

Finding 3. The students who self-rated themselves less experienced, and also performed poorer on the pretest, did not perform poorer on the post-course assignment regardless of method of instruction.

Finding 4. Students with very different levels of incoming experience and knowledge performed equally well on the post-course assignment after receiving either the in-class or computer-based methods of instruction.

Findings on Instructional Method Effectiveness.

Findings from the Literature. The Burns meta-analysis of 40 prior studies found that CBI programs were significantly more effective in promoting increased student achievement at both the elementary and secondary instruction level (4:3). The Kulik meta-analysis of secondary school studies found that in 39 of the 48 studies, students from the CBI classes scored higher on examinations (19:22). It also stated that of 25 statistically significant studies, 23 favored higher CBI class achievement, concluding that CBI is moderately more effective than traditional classroom instruction in secondary schools (19:22-23).

The Kulik meta-analysis of 59 college level studies found that CBI is effective at the college level, but to a lesser degree than in secondary schools. It concluded that CBI has at best a small effect on achievement at the college level (18:536).

At the secondary school level, the effectiveness of CBI was especially clear in studies of disadvantaged and low aptitude students, but smaller in studies of talented students (19:25-26). The Kulik college-level meta-analysis found increased CBI achievement in highly achieving students, and disadvantaged students (18:536). Burns found that achievement of average level students was not significantly enhanced by CBI (4:3).

In his meta-analysis of 82 CBI related dissertations and studies, Roblyer found no statistically significant evidence of a relationship between student ability level and the effectiveness of computer-based applications (26:54).

Findings from This Research. Chapter II described the methodology used to measure instructional method effectiveness. Table

8 presents the students' mean scores on each post-course assignment evaluation element, and the mean overall ratings. The data are arranged by each instructor's ratings (instructor 1 and instructor 2), and by the instructors' combined ratings (Both).

TABLE 8

THE MEAN RESULTS FROM THE INSTRUCTORS' EVALUATIONS OF THE POST-COURSE SPREADSHEET ASSIGNMENTS ARRANGED BY INSTRUCTOR AND STUDENT GROUP

	Student Groups								
	Combined Groups			CBI Group			In-class Group		
	Inst. 1	Inst. 2	Both Inst.	Inst. 1	Inst. 2	Both Inst.	Inst. 1	Inst. 2	Both Inst.
Achieved project goals:	14.5	12.6	13.0	14.8	13.2	13.3	14.2	12.3	12.8
Creativity:	4.4	3.3	4.0	4.4	3.7	4.2	4.4	3.5	3.9
Documentation:	4.3	3.3	3.8	4.3	3.3	4.0	4.3	3.3	3.7
Effective use of spreadsheet capabilities:	8.9	6.4	7.4	8.9	6.1	7.5	8.9	6.6	7.4
Layout and organization:	8.9	6.1	7.3	9.0	5.5	7.3	8.8	6.5	7.3
OVERALL RATING:	40.9	32.0	35.3	41.4	31.9	35.7	40.5	32.1	34.9

In the evaluations made by both course instructors (Both), the CBI group scored as high or higher than the in-class group in each project element and in the overall ratings. A median test (30:197-199) showed 52 percent of the CBI students and 40 percent of the in-class students scored above the post-course assignment median score. A Kruskal-Wallis nonparametric test (21:965-969; 30:193-196) concluded that there is not enough evidence (at a .05 alpha) from the post-course assignment data to reject the hypothesis that the CBI and in-class students' scores are the same.

A potential confounding variable to the post-test results was the difference in ratings between the instructors. Table 8 shows that instructor 2 consistently rated students lower than instructor 1. Table 9 indicates that instructor 2 evaluated fewer of the CBI students' assignments than instructor 1.

TABLE 9

THE NUMBER OF STUDENTS THAT EACH INSTRUCTOR RATED ARRANGED BY INSTRUCTOR AND STUDENT GROUP

Instructor	Total Students	CBI Students	In-class Students
Instructor 1	57	31	26
Instructor 2	46	15	31
TOTAL:	103	46	57

This difference could potentially skew the instructors' combined data in favor of the CBI group. To determine whether such skewing occurred, a separate Kruskal-Wallis test was performed on the ratings from each of the instructors. The tests revealed that there was no significant difference between the CBI and in-class post-course assignment ratings for either of the two instructors (at a .05 alpha). There was no significant difference between the CBI and in-class group post-course assignment scores with the instructors' ratings combined or with either instructor's individual ratings. Therefore, there was no significant difference in performance on the post-course assignment between the CBI group students or in-class group students. The CBI group performed as well as the in-class group.

Finding 5. The computer-based mode of instruction was as effective in producing student learning as the in-class mode of instruction.

Findings on Instructional Method Efficiency.

Findings from the Literature. The reviewed articles agreed that in courses for which a valid CBI program had been implemented and efficiency records maintained, the students learned the same course material in less time using CBI than by traditional classroom means of instruction. The Kulik college level meta-analysis stated that the most dramatic finding was related to instructional time.

> In every study in which computer-based instruction substituted for conventional teaching, the computer did its job quickly—on the average in about two-thirds the time required by conventional teaching methods. It is clear that the computer can function satisfactorily in college courses and at the same time reduce time spent in instruction. (18:538)

The Burns meta-analysis concurred that all studies reporting on efficiency showed it took less time for students to learn the same course material through CBI than through conventional instruction methods (4:35).

Findings from This Research. As described in Chapter II, a survey of the CBI group students (administered after they had completed the CBI course and received their scores from the post-course assignment) asked them to log the amount of time they spent using the CBI program. A copy of the survey is provided in Appendix C. The CBI students completed and returned 41 of the 46 surveys, for an 89 percent response rate. The mean time that the students reportedly spent using the CBI program was 160 minutes (2 hours and 40 minutes). The in-class students were each required to attend 480 minutes (8 hours) of direct instruction in the computer classroom. This data indicates that the in-class students were required to receive three times more instructional time than was used by the average CBI group student to cover similar course material.

Finding 6. The computer-based mode of instruction produced more efficient learning than the in-class mode. The students taking the course by CBI used substantially less time than the in-class students to learn the same course material.

Findings on Student Attitudes and Opinions.

Findings from the Literature. Students' attitudes toward subject matter were difficult to measure due to the lack of studies, varying rating methods, and differing definitions of a "positive attitude." Chan found that 80 percent of the elementary school teachers who responded felt CBI improved students' attitudes (5:112). The Kulik secondary school meta-analysis stated that most studies reporting on student attitudes find CBI students have more positive attitudes toward the study material (19:24). The Roblyer meta-analysis agreed that CBI students tended to have more positive attitudes, but found few studies to support that finding (26:55). In the Kulik college level meta-analysis, only 11 of 59 studies reported on student attitudes. The CBI students' attitudes were higher in eight, but statistically significant in only four of the studies (18:53).

Findings from This Research. As mentioned in Chapter II, the post-QMGT 290 student survey was used to solicit the CBI students' attitudes and opinions on the CBI program they completed, and on CBI in general. The Likert scaled responses were normalized to a 1 (low) to 10 (high) point scale. Table 10 lists the areas that the students rated, and the mean scores of the students' responses.

As Table 10 indicates, the CBI students had a strong, positive attitude toward CBI in all of the question areas.

Finding 7. After the course, the CBI students demonstrated a strong positive attitude about CBI, and the specific CBI course they completed.

TABLE 10

MEAN SCORES OF THE NORMALIZED RESPONSES OF THE CBI STUDENTS TO THE ATTITUDE AND OPINION QUESTIONS ON THE POST-QMGT 290 STUDENT SURVEY

Question Area	Means of the Responses (1=low, 10 = high)
Effectiveness of the CBI Program	7.9
Ease of Use of the CBI Program	8.3
The author's writing style	8.5
Value of the CBI program in helping do the post-course assignment	6.6
Feelings about CBI as a learning tool	8.5

The lowest attitudinal rating was the students' opinions on the value of the CBI program in helping them do the post-course assignment. This slightly lower rating could be attributable to the fact that the post-course assignment required the students to use a spreadsheet function that was not specifically addressed in the CBI program. (Although Quattro Pro "@" [at] functions in general were determined to be a course requirement, no specific @ functions were identified. Some Quattro Pro @ functions were addressed by the CBI, but not the specific @IF function that was used in the post-course assignment. The @IF function was addressed in the in-class instruction.) This slight difference in course content between the in-class instruction and the computer-based instruction probably did not have a major impact on the findings of this study. More significant differences could affect the researcher's ability to precisely compare the instructional methods.

The survey also asked for other opinions from the students. Of the 41 respondents, 36 (or 88 percent) felt that if the course material were appropriate, other courses at AFIT should be taught by the CBI method. When asked to indicate the types of computer users they would recommend to take the CBI course they had just completed, 24 (59 percent) of the students recommended inexperienced computer users, 36 (89 percent) recommended moderately experienced users, and 22 (54 percent) recommended very experienced computer users. This response is interesting in view of the fact that students of very different levels of experience and knowledge performed equally well on the post-course assignment. From the students' written comments, some felt that inexperienced users needed human instructor interaction to get started with the CBI program and the new spreadsheet package. This feeling could be attributable to the initial difficulty some students faced in loading and starting the CBI program. Although the CBI program start-up procedures were thoroughly tested by the researcher and three other AFIT students just one week prior to the beginning of the CBI course, unforseen problems occurred that caused confusion among some of the CBI students. One such problem was a major change in the default screen layout of the upgraded version of Quattro Pro that some students purchased. The CBI program was written in the macro language of Quattro Pro version 2.0. Many of the students purchased the newer Quattro Pro version 3.0. Although the macro language was totally compatible, a change to the default screen layout of version 3.0 (a "what you see is what you get" environment) caused confusion among students. The problem itself was easily corrected; communicating the correction to each student in a timely fashion was initially difficult. This problem demonstrated a potential limitation in CBI programs that are designed for specific versions of software.

Finding 8. Software upgrades or changes could significantly affect the usability and/or quality of a CBI program.

A log of other reported problems that the CBI students encountered is provided in Appendix D.

A little over half of the respondents did not recommend the CBI program for very experienced computer users. One purpose of the spreadsheet unit of QMGT 290 was to provide the students the knowledge and ability to use automated spreadsheets in their graduate program. Since the more experienced computer users might have already possessed that ability, they may have felt that the CBI program was simply a review, and thus not necessary.

Other Findings from This Research.

A Comparison of the Scores of the In-class Students to the CBI Students on the Pre-course Spreadsheet Knowledge Test. A median test on the results of the pre-course spreadsheet knowledge test revealed that 55 percent of the CBI students, and 40 percent of the in-class students scored higher than the median score. A Kruskal-Wallis test found that there was enough evidence from the data to reject the hypothesis that the scores were the same (at a .05 alpha).

Finding 9. The students who volunteered to take the course by the computer-based mode scored higher on the pre-course knowledge test than the students who volunteered to participate in the experiment by the traditional mode.

Pre-course Spreadsheet Knowledge Compared to Post-course Spreadsheet Assignment Performance. A Spearman Rank Correlation test found no correlation (-0.03) between the pre-course spreadsheet knowledge test and the post-course spreadsheet assignment scores with the CBI and in-class groups combined. The CBI group's scores had a small. positive (0.41) correlation, while the in-class group's scores had a weaker (0.21) correlation. There is no evidence to indicate that students scores on the pre-course knowledge test were strongly correlated with their scores on the post-course assignment.

A Comparison of the Required Resubmission Rates of the CBI Group and the In-class Group. Students who did not meet minimum achievement standards were required to correct and resubmit their post-course assignment. Table 11 shows the required resubmissions arranged by instructor and student group.

Overall (TOTAL), the CBI students had a lower resubmission rate than the in-class group. By percentages, instructor 1 required fewer CBI group resubmissions, while instructor 2 required fewer in-class group resubmissions. There is not sufficient data to determine whether there is a significant difference in the required resubmissions between the student groups.

Literature Review Findings on CBI Course Completion. Chan found that at the elementary school level, slower learning students were more likely to complete the CBI. The learning disadvantaged students

TABLE 11

THE NUMBERS OF STUDENTS REQUIRED TO RESUBMIT THEIR POST-COURSE ASSIGNMENT PROJECTS

	Student Groups		
	Both Groups	CBI Group	In-class Group
	(% tot)	(% CBI)	(% in-class)
Instructor 1	8 (14.0%)	2 (6.9%)	6 (21.4%)
Instructor 2	8 (17.4%)	3 (20.0%)	5 (16.1%)
TOTAL:	16 (15.5%)	5 (11.4%)	11 (18.6%)

Note: The percentages (other than TOTAL) are percentages of the total number of students rated by the particular instructor in the particular student group. Example: For Instructor 1, the 6.9 % (under the CBI Group) represents the percentage of the total number of CBI student assignments that instructor 1 evaluated and required to be resubmitted.

preferred computer interaction over human interaction due to the lack of negative feedback and infinite patience of the machine. Often computer-based lessons revitalized their interest (5:112-113). The Kulik college level meta-analysis found 13 studies reporting on CBI course completion. In seven of the studies withdrawal rate was higher in the CBI section, and in six studies withdrawal rate was higher in the conventional section (18:536). The article found no significant difference in course completion between CBI and conventional teaching methods (18:536). The Hoffman personality type article found that all sensing types tended to complete the CBI sooner than the intuitive types. The extraverted perceptive types overwhelmingly tended to drop out of the CBI program (16:21). The article found that the CBI course withdrawal rate is related to student characteristics rather than course delivery method (16:20).

A Review of the Major Findings.

For the convenience of the reader, this section repeats the major findings of this research project. All findings should be interpreted within the scope of this study.

Finding 1. Both (self-reported) prior spreadsheet experience and prior computer experience were effective indicators of pre-course subject matter knowledge for both the CBI and in-class groups.

Finding 2. Neither (self-reported) prior spreadsheet experience or prior computer experience were good indicators of performance on the post-course assignment for students in either group.

Finding 3. The students who self-rated themselves less experienced and also performed poorer on the pretest, did not perform poorer on the post-course assignment regardless of the method of instruction.

Finding 4. Students with very different levels of incoming experience and knowledge performed equally well on the post-course assignment after receiving either the in-class or computer-based methods of instruction.

Finding 5. The computer-based mode of instruction was as effective in producing student learning as the in-class mode of instruction.

Finding 6. The computer-based mode of instruction produced more efficient learning than the in-class mode. The students taking the course by CBI used substantially less time than the in-class students to learn the same course material.

Finding 7. After the course, the CBI students demonstrated a strong positive attitude about CBI, and the specific CBI course they completed.

Finding 8. Software upgrades or changes could significantly affect the usability and/or quality of a CBI program.

Finding 9. The students who volunteered to take the course by the computer-based mode scored higher on the pre-course knowledge test than the students who volunteered to participate in the experiment by the traditional mode.

IV. Conclusions and Recommendations

Chapter Overview

This chapter presents the conclusions drawn from the research and offers recommendations for future computer-based experiments or studies. The conclusions should be interpreted within the scope of this study. All of the conclusions are presented first, followed by the recommendations.

Conclusion 1

The computer-based method of instruction was significantly more efficient and produced learning effects similar to the in-class method of instruction for all students. The AFIT School of Systems and Logistics may realize important time savings by using the CBI mode for this or similar course material.

Conclusion 2

Since the student characteristics at the beginning of the course were offset by learning from either instructional mode, and since the CBI was as effective as the in-class mode, faculty can safely assign students to CBI in the belief that the students will learn as effectively as they would learn in the classroom, regardless of the students' initial knowledge or experience level.

Conclusion 3

Self-reported subject matter experience was a reasonably effective indicator of actual pre-course subject matter knowledge among the students. Faculty could use the students' self-reported experience to achieve better balanced classes, and/or to determine what level (e.g., novice, intermediate, experienced) of a modularized CBI program to assign to the students.

Conclusion 4

Since prior experience and knowledge were not closely correlated with the post-course assignment performance, it can be inferred that the course presented in either instructional mode made some type of difference in the students' knowledge level.

Conclusion 5

The students who performed poorly on the pre-course knowledge test, and who reported themselves low in experience and knowledge, were not identifiably weaker after receiving instruction from either instructional mode. Both modes had a "leveling" effect, perhaps giving the most benefit to the initially "weaker" students.

Conclusion 6

If the use of CBI is voluntary, the students who consider themselves more experienced and who are (initially) more knowledgeable are more likely to volunteer.

Conclusion 7

With very few exceptions, the students who volunteer for CBI can be expected to feel positive about the use of CBI at the end of their learning, regardless of their initial experience or knowledge levels.

Recommendation 1

The AFIT School of Systems and Logistics should consider producing CBI programs for other courses that have common variables and are similar in course content to the spreadsheet unit of QMGT 290. This research showed that CBI can be as effective and more efficient than in-class instruction in teaching basic spreadsheet functions. A logical next step is to investigate CBI's effectiveness and efficiency with other units of QMGT 290, specifically the units on introduction to databases and introduction to word processors. It is possible that much of QMGT 290 could be taught by CBI. Since computers are becoming increasingly commonplace, a CBI course could be distributed and taken by students before they arrive at AFIT.

Recommendation 2

Although CBI is an effective instructional mode, it should not be assumed that CBI is desirable, suitable, or feasible for all types of course material. A thorough cost-benefits analysis should be performed to determine the desirability, suitability, and feasibility of a CBI program for a particular course. Creating a CBI program requires a large amount of planning, preparing, programming, testing, and resourcing. Purchasing "off-the-shelf" CBI could require a large capital investment. Consideration should be given to the resources that are required to implement a CBI program, including computer hardware, computer software, programmer(s), facilities, and software distribution media (floppy disks, installation guides). CBI should be considered practical only after a cost-benefits analysis reveals that the potential benefits of CBI (improved learning efficiency, standardization, convenience, flexibility, and self-paced learning) outweigh the total qualitative and quantitative costs.

Recommendation 3

CBI should not be targeted towards a specific version of computer software. The Quattro Pro software package used for this research was upgraded by the manufacturer twice in less than one year. The changes caused minor problems for the students who had purchased the latest version. Also, computer software is becoming increasingly homogeneous. The specific name brand of software used in a course could change between course offerings, potentially rendering a CBI program obsolete. The hazards of software changes and obsolescence should be considered prior to writing a CBI program.

Recommendation 4

Another factor contributing to CBI obsolescence is changes in course material between or during course offerings. Small changes in the course material could add a significant amount of time to the programming task of updating earlier CBI lessons. Changes made just before or after the course begins would be difficult to include in the CBI program. The computer-based method of instruction should be considered only for those courses that change infrequently.

Recommendation 5

The CBI author should ensure that the CBI program is flexible enough to accommodate the novice user while allowing the more experienced or knowledgeable user to rapidly complete the course material. A recommended approach is to modularize the CBI program at the student ability levels. An author could divide the CBI program into novice, intermediate, and advanced modules, and assign the modules based on the students' self-reported experience levels.

Closing Remarks

It is clear that technological advances will play an increasingly large role in the future of education and training. All educational organizations, including AFIT, must continue to investigate the potential of state-of-the-art educational technologies such as interactive video disk (IVD), robotics, telecommunications, expert systems, simulations, voice recognition, and neural systems. As this research demonstrated, one educational technology with great potential is computer-based instruction.

Appendix A: The Course Director and Course Instructor Survey

Survey Instructions

1. Based on your experience and expertise, you are requested to participate in a research project. Your responses to the items in this survey will help determine specific requirements for a computer based version of the automated spreadsheet unit of QMGT 290, Introduction to AFIT Computer Systems.

2. The researcher will personally administer this survey.

3. Open responses are encouraged. If you feel the survey does not adequately address any issues, please feel free to comment or add additional information.

4. For the purpose of this survey, NON-MECHANICAL concepts are techniques, ideas, functions, or operations that you believe are important to any spreadsheet usage regardless of the internal capabilities of the automated spreadsheet package. MECHANICAL concepts are techniques, ideas, functions, or operations directly related to the internal capabilities of an automated spreadsheet package.

5. This survey begins with NON-MECHANICAL concepts, followed by generalized MECHANICAL concepts. Each MECHANICAL concept is then broken down into specific spreadsheet functions. The survey concludes with a prototype standardized project evaluation form provided for your recommendations and comments.

6. Thank you for your assistance and support of this research project.

Russell A. Greene

NON-MECHANICAL CONCEPTS	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
1 AFIT LAN considerations				
2 AFIT spreadsheet software availability				
3 DOS				
4 commercial spreadsheet availability				
5 data backup				
6 definition				
7 documentation				
8 formulas				
9 hard/floppy disk file management				
10 hardware requirements				
11 keyboard layout/functions				
12 logical design techniques				
13 mouse functions				
14 physical layout/organization				
15 printer functions				
16 software copyrights				
17 software loading				
18 software requirements				
19 spreadsheet uses/applications				

MECHANICAL CONCEPTS

	MECHANICAL CONCEPTS	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
20	basic math functions				
21	cell blocks				
22	cells				
23	columns				
24	database				
25	edit				
26	file				
27	graph				
28	macros				
29	menus				
30	other advanced operations				
31	other general operations				
32	print				
33	rows				
34	setup options				
35	windows				

MECHANICAL CONCEPTS

BASIC MATH FUNCTIONS

		Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
35	add				
36	auto recalculation				
37	divide				
38	multiply				
39	subtract				

CELL BLOCKS

		Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
40	change/set alignment				
41	copy blocks				
42	erase blocks				
43	fill blocks (numbers)				
44	move blocks				
45	name blocks				

CELLS

		Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
46	copy cells				
47	erase cells				
48	modify cell formats				
49	move cells				
50	name cells				

		Is a course requirement? / Emphasis correct?	Should be a course requirement?	Will you teach it?	Relative importance rating:
	COLUMNS				
51	change\set column width				
52	delete columns				
53	hide\expose columns				
54	insert columns				
	DATABASE FUNCTIONS				
55	copy a database				
56	create a database				
57	limit data type input				
58	query database				
59	restrict data entry input				
60	sort database				
	EDITING				
61	change/set font				
62	draw lines				
63	edit data				
64	insert page breaks				
65	search and replace				
66	set protection				
67	shade				
68	transpose				
69	use undo				

No.	Task	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
	FILES				
70	call up an existing file				
71	change directory				
72	erase a file				
73	open a new file				
74	retrieve an existing file (replace current)				
75	save a file				
76	use file utilities				
	GRAPHING				
77	add text				
78	choose graph type				
79	create a graph				
80	customize series				
81	hide graph				
82	insert graph into spreadsheet				
83	modify X and Y axis				
84	name graph				
85	print graph				
86	specify series				
87	use fast graph				
88	use overall to modify graph (3d, colors, grids)				
89	use the annotator to annotate graphs				
90	use the annotator to create text graphs				
91	view graph				

MACROS

#	Task	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
92	create a macro				
93	debug a macro using the macro debugger				
94	play a macro				
95	record macros using the macro record mode				

MENUS

#	Task	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
96	create custom menus				
97	select menu trees				

OTHER ADVANCED OPERATIONS

#	Task	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
98	advanced math functions				
99	change print layout				
100	change spreadsheet print format				
101	choose print destination				
102	combine blocks or files				
103	format labeled blocks				
104	frequency count				
105	import text files				
106	link spreadsheets				
107	parse				

OTHER ADV OPERATIONS CONT.

No.	Item	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
108	print spreadsheet				
109	retrieve 1-2-3 files				
110	save and restore a workspace				
111	select menu trees				
112	shortcut keys				
113	sort,find, and extract database records				
114	use adjust printer command				
115	use the built-in SQZ! function				
116	use the file manager				
117	use transcript				
118	use what-if				
119	xtract into separate file				

OTHER GENERAL OPERATIONS

No.	Item	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
120	create and enter formulas				
121	enter data				
122	enter spreadsheet				
123	exit spreadsheet				
124	preview spreadsheets to screen				
125	search and replace spreadsheet values				
126	use the pull down menu				

PRINTING

#	Item	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
127	change print layout				
128	change spreadsheet print format				
129	choose headings				
130	choose print destination				
131	print spreadsheet				
132	set print blocks				
133	use adjust printer command				

ROWS

#	Item	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
134	delete rows				
135	insert row				

	SETUP OPTIONS	Should be a course requirement?	Is a course requirement? / Emphasis correct?	Will you teach it?	Relative importance rating:
136	modify colors				
137	modify display mode				
138	modify graphics quality				
139	modify mouse pallet				
140	modify startup options.				
141	set global formats				
142	set protection mode				
143	set recalculation mode				
144	set undo command				
145	set\change hardware options				
146	update (save) setup changes				

	WINDOWS				
147	move/size windows				
148	open multiple windows				
149	pick windows				
150	split windows				
151	stack windows				
152	tile windows				
153	zoom window				

Appendix B: The Evaluation Form for the Post-Course Spreadsheet Assignment

Spreadsheet Project Evaluation Form

Student' Name: ____________________________

	Relative Achievement						
	LO <———				———> HI	Weight	
Achieved project goals	____	____	____	____	____	X 3 =	____
Creativity	____	____	____	____	____	X 1 =	____
Documentation (on/off disk)	____	____	____	____	____	X 1 =	____
Effective use of spreadsheet capabilities	____	____	____	____	____	X 2 =	____
Layout/Organization	____	____	____	____	____	X 2 =	____
	1	2	3	4	5		

OVERALL RATING: ____

Appendix C: The Post-QMGT 290 Student Survey

Post CBI Student Survey Ctrl # ____

Thank you for completing the Introduction to Spreadsheets Computer Based Instruction (CBI) program, and for taking time to fill out this survey. The control number you find at the top of this page is NOT controlled by name, and is for analysis purpose only. No individual data will be released. All analyses and findings will be based on group trends, NOT individual data.

The purpose of this survey is to collect your opinions on the effectiveness and efficiency of the CBI program, and to solicit your comments and recommendations for future improvements. Please place a tick mark on the rating scales at the point you feel best answers each particul ` question.

1. The objective of the CBI program was to teach you some basic spreadsheet features and functions. How EFFECTIVE was the CBI program in meeting its objective?

Completely Ineffective	1	2	3	4	5	6	7	Highly Effective

2. How many sessions, and approximately how much time per session did you spend with the CBI program? NOTE: Include ONLY the time you used the CBI program. Do NOT include the time you spent on the projects or things external to the CBI program.

____ sessions at approximately ____ MINUTES per session

3. Please rate the CBI tutorial program in the following areas:

Ease of use:	Extremely Difficult	1	2	3	4	5	6	7	Extremely Easy
The author's writing style:	Unclear and Hard to Understand	1	2	3	4	5	6	7	Clear and Easy to Understand
Value in helping you do the FINAL project:	Not Valuable at All	1	2	3	4	5	6	7	Extremely Valuable

4. Philosophically, how do you feel about CBI as a learning tool:

Extremely Negative	1	2	3	4	5	6	7	Extremely Positive

5. Assuming the course material were appropriate for CBI, should other courses at AFIT be taught by CBI?

YES ____ NO ____

6. Use the space below, the back of this sheet, or a separate sheet to make suggestions or comments on problems, or "bugs" you encountered when using the CBI program. Please be as specific as possible.

____

____

____

____

____

____

7. Use the space below, the back of this sheet, or a separate sheet to make suggestions or comments on the CBI course, or CBI in general.

____

____

____

____

____

____

8. Which of the following types of computer users would you recommend take the CBI course (check all that apply):

____ inexperienced computer users

____ moderately experienced computer users

____ very experienced computer users

____ none of the above

Appendix D: The Major Problems that the Students Reported Relating to Use of the CBI Software

Problem 1: The format for the screen default on the newer version of Quattro Pro (version 3.0) was not compatible with the format of the CBI program screens.

Solution: The students were instructed how to change the screen default on the newer Quattro Pro version, making it compatible with the CBI.

Problem 2: Some students had problems loading the CBI on the School of Systems and Logistics' computers due in part to the local area network setup.

Solution: Printed instructions were distributed providing students step-by-step instructions on how to load the CBI on the local area network.

Problem 3: Students could not get the Quattro Pro software that was loaded on the School of Systems and Logistics Computers to print graphs.

Solution: The School of Systems and Logistics computer managers were notified and attempted to fix the problem. The problem was not solved prior to completion of the CBI course.

Problem 4: A few students could not successfully load and start the CBI program.

Solution: The students who raised the problem were assisted individually by the CBI author in loading and starting the CBI program.

Appendix E: Post-course Spreadsheet Assignment

QMGT 290 - Spreadsheet Project

1. Create a spreadsheet containing your ed plan. (See LSOI 50-1, Attachments in your 1992S/D Graduate Programs Handbook if your advisor hasn't given you a copy of your ed plan.) Include appropriate column headings.

2. Use the spreadsheet to compute and display the following pieces of data:
    a. number of credit hours in each term (quarter)
    b. total number of credit hours
    c. number of credit hours by department
    d. percentage of total credit hours by department
    e. total thesis hours
    f. percentage of total hours dedicated to thesis

NOTE: Do not "hard-code" these formulas. i.e. Perform the calculations in such a way that no formulas would have to be changed if you replaced a course in one department with a course from another department.

HINT: You may want to facilitate calculation of hours by department by creating a separate work area in your spreadsheet which picks out the hours relevant to each department using @IF functions.

3. Create graphs which show:
    a. workload (credit hours) by quarter (bar chart)
    b. workload (credit hours) by department (pie chart)

4. Print the spreadsheet. Include a header with your name and section. Beginning two lines below the end of the spreadsheet (but beginning on the same page), display the cell contents for each item computed in #2 above. i.e. Show me an example of each of your formulas.

5. Print both of your graphs on a single sheet of paper.

6. Staple your sheets together and turn in NLT Monday, 24 Jun 91.

Appendix F: Examples of CBI Lesson Frames

The SPREADSHEET WINDOW is the rectangular area on which this text is displayed. It is made up of cells where you enter display and organize information. Each cell has an address which includes a vertical column letter and a horizontal row number. The column letter is found just above the spreadsheet window. The row number is just left of the spreadsheet window. This spreadsheet window shows columns I-P and rows 39-58. The entire spreadsheet, however, has 256 columns (lettered A-Z then AA-AZ BA-BZ etc. up to IV) and 8192 rows.

TAB to continue SHIFT TAB to backup ALT T to test ALT Q to quit

TRY THIS -> Move the cell selector to BA133. Notice the input line displays the formula (+AY133+AY135) while the cell displays the formula results (160). The formula adds the contents of AY133 (100) to the contents of AY135 (60). While the cell selector is still at BA133 press the F2 key to enter the edit mode. Experiment with the formula contents using the four arithmetic operators. If you get an error message (ERR) enter a corrected formula.

TAB to continue SHIFT TAB to backup ALT T to test ALT Q to quit

Appendix G: <u>Examples of CBI Test Frames</u>

Answer each question by pressing the letter corresponding to the correct answer.

Question 1. The spreadsheet window is made up of _____ where you may enter display and organize information.

a. pallets
b. memory allocation units
c. labels
d. cells

Select a, b, c, or d

The correct answer is D.

The spreadsheet window is made up of <u>CELLS</u> where you may enter display and organize information.

Press TAB to continue

Appendix H: A Survey of the Students who had Completed QMGT 290 Prior to the Research Period

Survey Questionnaire Instructions

1. Based on your successful completion of the summer short term course Introduction to AFIT Computer Systems (QMGT 290), you are requested to participate in a research project. Your responses to the items contained in this survey questionnaire will be used to assess the availability of the computer resources required for a computer-based instruction course.

2. Anonymity is assured as no identifying data is requested. Individual responses will not be released.

3. If you feel the survey does not adequately address any issues, please feel free to comment or add additional information.

4. Please place your completed questionnaire in Russ GREENE's mail (distribution) box today, or as soon as possible.

QMGT 290 Former Student Survey

1. Do you own a personal computer?

   YES ____ NO ____ (If NO, skip to question 6)

2. Please specify the type of computer(s) you own.

   DOS ____ MACINTOSH ____ OTHER ____

3. Did you purchase a computer after arrival at AFIT?

   YES ____ NO ____

4. Was your computer set up and ready for use by the beginning of the summer short term?

   YES ____ NO ____

5. Did you use your computer for the summer short term course QMGT 290, "Introduction to AFIT Computer Systems"?

   YES ____ NO ____

6. Do you feel AFIT's Z-248 personal computers are adequately available for your use?

YES ____ NO ____ (If NO, please explain)

____

____

(continue on reverse if necessary)

7. Did you use an automated spreadsheet program before coming to AFIT?

YES ____ NO ____ (If yes, please specify program name)

____

8. Did you own an automated spreadsheet program before coming to AFIT?

YES ____ NO ____

____

9. Did you use Quattro Pro for the QMGT 290 (Introduction to AFIT Computer Systems) project(s)?

YES ____ NO ____

10. If you had the option to take the spreadsheet portion of QMGT 290 by the current classroom method or by a tutorial program on a computer disk (computer based instruction), which method would you prefer?

Classroom ____ Tutorial Disk ____ No Preference ____

11. Have you ever taken a course by computer based instruction?

YES ____ NO ____

12. If you have any comments or suggestions that would be helpful in designing and implementing a computer based instruction course for the spreadsheet portion of QMGT 290, please write them below.

____

____

____

____

____

(continue on reverse if necessary)

Appendix I: General Findings from the Survey of Students who had Completed QMGT 290 Prior to the Research Period

Thank you for your participation in this survey. Your collective responses are provided below. A special thanks for all the constructive comments. Your collective (not individual) comments will be provided to the QMGT 290 course director for potential improvements. Of the 135 surveys distributed, 89 were completed and returned for a 65.9 percent response rate. Some response percentages do not add to 100 percent due to "no responses" or rounding error. Once again, thanks for your support and concern.

Student Survey Collective Responses

1. Do you own a personal computer?

   YES 97.8% NO 2.2% (If NO, skip to question 6)

2. Please specify the type of computer(s) you own.

   DOS 93.4% MACINTOSH 5.5% OTHER 1.1%

3. Did you purchase a computer after arrival at AFIT?

   YES 49.5% NO 50.5%

4. Was your computer set up and ready for use by the beginning of the summer short term?

   YES 64.8% NO 35.2%

5. Did you use your computer for the summer short term course QMGT 290, "Introduction to AFIT Computer Systems"?

   YES 74.7% NO 24.2%

6. Do you feel AFIT's Z-248 personal computers are adequately available for your use?

   YES 68.8% NO 28.0% (If NO, please explain)

COMMENT TRENDS FROM HIGH TO LOW RESPONSE RATE:

1. Computers are too slow.
2. Printer problems (not adequate, ribbons, working condition, etc.)
3. Computers are adequate only because most students use their own computers.
4. Software problems (inadequate, not standardized between computers, slow)
5. Computers are in poor working condition.

7. Did you use an automated spreadsheet program before coming to AFIT?

YES 48.4% NO 51.6%

8. Did you own an automated spreadsheet program before coming to AFIT?

YES 29.0% NO 71.0%

9. Did you use Quattro Pro for the QMGT 290 (Introduction to AFIT Computer Systems) project(s)?

YES 88.2% NO 11.8%

10. If you had the option to take the spreadsheet portion of QMGT 290 by the current classroom method or by a tutorial program on a computer disk (computer based instruction), which method would you prefer?

Classroom 51.6% Tutorial Disk 31.2% No Preference 17.2%

11. Have you ever taken a course by computer based instruction?

YES 36.6% NO 63.4%

12. If you have any comments or suggestions that would be helpful in designing and implementing a computer based instruction course for the spreadsheet portion of QMGT 290, please write them below.

COMMENT TRENDS FROM HIGH TO LOW RESPONSE RATE:

1. Make CBI user friendly, especially for computer inexperienced students.
2. Use CBI to supplement, not replace instructor.
3. Keep in mind the vast differences in student computer experience levels.
4. Teach more DOS and computer basics. Do not assume students know DOS.
5. Allow students to test out of QMGT 290.
6. Teach more about spreadsheets to better prepare students for follow-on courses.
7. Concentrate spreadsheet instruction on practical rather than abstract applications.
8. Make CBI self-paced.
9. Build to one major graded project with smaller sub-projects.
10. Use Lotus 123 computer-assisted instruction modified for Quattro Pro.
11. Eliminate QMGT 290.
12. Notify incoming students prior to arrival of the software used at AFIT.
13. Use an accompanying CBI workbook with the CBI lessons.

Appendix J: Survey of the Incoming Students who would Take QMGT 290 During the Research Period (Pre-QMGT 290 Survey)

WELCOME to AFIT

One of your first courses at AFIT will be QMGT 290, Introduction to AFIT Computer Systems. Offered in the summer review term, this course will help you "get up to speed" on AFIT's computer resources used in other courses. This summer, you and other members of Class 92 will help us test a new method of course delivery. Specifically, some of your class will study the spreadsheet portion of QMGT 290 in the traditional classroom method, while others will study spreadsheets through a new, self-paced, tutorial on computer disk. At the end of the term, we will compare the effectiveness of the two methods and user's preferences. If, as we believe, the convenience of a self-paced tutorial enhances learning and helps users better manage their time, AFIT may adapt other courses for computer-based instruction.

Let us emphasize that this project is designed to ensure effective learning for students in both groups. Both versions of the course will cover the same material, and instructor support will be equally available to everyone. Since QMGT 290 is graded only "Satisfactory/Unsatisfactory," no one's final grade will be negatively affected by either method of instruction. Students in the tutorial group may use their home computers or use AFIT's computers during non-class hours.

To create a valid research design, we need to ensure that the two groups are "mirror images" of each other in terms of prior knowledge of computers, spreadsheets, and related variables. The attached questionnaire will help us achieve that comparability. Here is the procedure:

- You complete the questionnaire, including a statement of your preference for which group you would like to be in.

- You return the questionnaire to the box on the counter of LSG (Room 316) BEFORE YOU LEAVE THE BUILDING TODAY.

- The researcher (CPT Greene) analyzes the questionnaires and establishes the two groups before the experiment starts. Only CPT Greene will see your responses, and all responses will be treated as confidential. Since each group will contain experienced and novice computer users and experienced and novice spreadsheet users, the faculty will not know how you answered any questions or the basis of assignment into either group.

Although you must take QMGT 290, your participation in the research is voluntary. If you want to be a candidate for the tutorial method, simply indicate that fact on the questionnaire and you will be excused from class on the "Quattro Pro" class days. However, to ensure the validity of the research (and to help the classroom instructors meet everyone's needs), it is very important that we receive a completed questionnaire from you. Be sure to submit your completed questionnaire to LSG before you leave today.

Thank you for helping AFIT help you.

Course Director, QMGT 290

PART I: Demographics

1. Last Name ________________ First Name __________________ MI ____

2. Rank or Grade: _______

3. Please indicate your branch of service:

   a. Air Force b. Navy c. Government Civilian
   d. Army e. Marine f. International Student
   g. Other (please specify) ___________________________

4. Please fill in the education level(s) you have completed. Specify the subject area, degree(s) earned, and approximate completion/graduation date (month and year) in the space provided (continue on the back of this sheet if necessary):

   a. undergraduate degree(s) subject area(s) ____________________
   degree(s) earned ____________________
   year __________

   b. graduate degree(s) subject area(s) ____________________
   degree(s) earned ____________________
   year __________

   c. others (for example technical schools, correspondence courses, significant military/government courses, etc.)

____

____

____

(Continue on reverse if necessary.)

5. Please indicate your <u>completed</u> number of years of government/military service:

   ______ years

6. Which AFIT graduate program are you enrolled in (for example, GEM, GLM, GCM, GIR, GSM, GCA, etc.)?

   ______

PART II: Computer Experience

Instructions for Part II: For the purpose of this questionnaire, a "personal" computer (PC) is a stand-alone microcomputer consisting of a central processing unit (CPU), a visual display, a keyboard input device, and one or more disk drives. Personal computers can also be referred to as "desktop," "home," "laptop," "notebook," or "portable" computers. Some commercial examples of PC's are IBM (sometimes referred to as MS-DOS systems), Apple, Commodore, and compatibles. In this questionnaire, references to "computers" that are not preceded by "personal" refer to <u>all</u> computers, including personal computers. Examples include mainframes, minicomputers, and personal computers.

Some of the questions will ask you to rate an item on the following scale:

```
Completely                                 Highly
Inexperienced  :--+--+--+--+--+--:  Experienced
               1  2  3  4  5  6  7
```

Place a tick mark on this scale at the point you feel best describes your experience level for the particular question topic. Below is an example of how to correctly mark the scale for a person who feels almost completely inexperienced with the particular topic.

```
Completely                                 Highly
Inexperienced  :--+--+--+--+--+--:  Experienced
               1  2  3  4  5  6  7
```

<u>Hardware</u>

1. Do you own one or more <u>personal</u> computers?

   YES ____ (If yes, how many? ____)
   NO ____ (If NO, skip to question 5.)

2. Is (are) your <u>personal</u> computer(s):

   IBM or Compatible? ____
   APPLE or Compatible? ____
   Other (please specify) ______________

3. In what year did you acquire your personal computer(s)?

Year(s) ________

4. Will you use your own personal computer for the summer short term?

YES ____ NO ____ (If NO, please specify why.)

____

____

(Continue on reverse if necessary.)

5. Did you use a computer prior to enrolling at AFIT?

YES ____ NO ____ (IF NO, skip to PART III.)

6. In what year did you first use a computer?

Year ________

7. Which of the following best describes your typical frequency of use of computers?

Very little	_____
Little	_____
A moderate amount	_____
Much	_____
Very much	_____

8. Place a check mark beside each of the following items that you could accurately define:

ANSI	_____	LPT 1	_____
CD ROM	_____	modem	_____
CPU	_____	motherboard	_____
floppy disk drive	_____	mouse	_____
input/output card	_____	serial port	_____

9. Consider for a moment your overall experience with computers. How would you rate your computer experience?

Completely Inexperienced |—+—+—+—+—+—| Highly Experienced
1 2 3 4 5 6 7

10. Please describe the education or training you have had in computer use. If none, enter "none."

____

____

Software

11. Please describe any computer software that you have personally written including the language and/or program. If none, state "none."

____

____

(Continue on reverse if necessary.)

12. Please rate your experience with the following software categories:

	Completely Inexperienced						Highly Experienced
CAD programs							
database programs							
draw, paint, or graphics programs							
entertainment programs							
math or statistical programs							
spreadsheet programs							
telecommunications programs							
utility programs							
word processing programs							
	1	2	3	4	5	6	7

Others you feel experienced with (please specify)

______________							
______________							
	1	2	3	4	5	6	7

PART III: Spreadsheet Experience

1. Have you used an automated spreadsheet program?

   YES ____ NO ____ (If NO, skip to PART IV)

2. What is the name of the spreadsheet program(s) you have used?

____

3. Please describe the nature of use, or for what purpose you used spreadsheet programs.

____

____

____

(Continue on reverse if necessary.)

4. Do you own an automated spreadsheet program?

YES ____ NO ____ (If NO. skip to question 7)

If YES, please specify the program name: ______________________

5. When did you obtain your automated spreadsheet program?

Year ________

6. For what purpose did you obtain your automated spreadsheet program?

____

____

(Continue on reverse if necessary.)

7. When did you first use an automated spreadsheet?

Year ________

8. Which of the following best describes your typical frequency of use of spreadsheets?

Very little _____
Little _____
A moderate amount _____
Much _____
Very much _____

9. Please indicate your experience level with the following spreadsheet functions or concepts:

	Completely Inexperienced					**Highly Experienced**	
	1	2	3	4	5	6	7
- blocking							
- database functions							
- editing							
- file management							
- graphing							
- math functions							
- printing spreadsheets							
- row and column operations							
- using formulas							
- using macros							
- windows							
- writing formulas							
- writing macros							

10. Overall, how would you rate your automated spreadsheet experience?

Completely Inexperienced	1	2	3	4	5	6	7	Highly Experienced

11. Have you ever taken a class in automated spreadsheet use?

YES ____ NO ____

If YES, please specify course, length, and date: ________________

____

(Continue on reverse if necessary.)

PART IV: Spreadsheet Knowledge

Instructions for PART IV: The results of this test will be used only for this research project. Individual responses will not be released. Please circle the answer that best fits the blank. It is important that you DO NOT GUESS. If you are not reasonably sure of an answer, mark the "I am not sure" block.

1. A spreadsheet cell has an address or location which is made up of _________ and ________ coordinates.

   A. block, column
   B. block, line
   C. row, column
   D. row, block
   E. I am not sure

2. A spreadsheet block normally consists of ________.

   A. more than one cell.
   B. two or more embedded macros.
   C. a series of graphical interface commands linking the spreadsheet to a graphical block display area.
   D. a set of special blocking codes.
   E. I am not sure

3. In an automated spreadsheet, pressing the right arrow key while the cursor is in a cell that contains a formula will ______________.

   A. execute the next sequenced autorecalculation.
   B. move the cursor one cell to the right.
   C. do nothing unless used in combination with another key.
   D. prompt the user for a cell value or label.
   E. I am not sure

4. The purpose of a user-defined macro is to ____________.

A. save all related spreadsheets under the same macro-group name.
B. create hidden definition blocks which are only visible when editing.
C. allow another user to simultaneously logon to the same spreadsheet program (assuming both spreadsheet macros modes are compatible).
D. allow the user to consolidate many keystrokes into a smaller number of keystrokes.
E. I am not sure

5. In most automated spreadsheet programs, _________ would compute the square of 54.

A. 54^2
B. 54 */2
C. 54 @sqr(2)
D. 54^@sqr(2)
E. I am not sure

6. In an automated spreadsheet, autorecalculation refers to the spreadsheet's ability to automatically ______________.

A. move all relevant mathematical formulas to a user defined location.
B. update formulas and calculations of other spreadsheets saved under the same group name.
C. update formula or calculation results when referenced cell values are changed.
D. allow the user to redefine referenced formula and calculation values prior to loading the spreadsheet.
E. I am not sure

7. To enter data into a empty (unprotected or unlocked) cell, you move the cursor to the cell, _________.

A. and enter the desired data.
B. define the data worksheet area, and then enter the data.
C. change the flag indicator on the cell, and then enter the data.
D. change the definition of the cell to a block, and then enter the data.
E. I am not sure

8. In most spreadsheet programs, entering a data string 20 characters long into a cell of width 8, results in the spreadsheet ________.

   A. automatically changing the cell to a block in order to accept the excess characters.
   B. not acknowledging the excess data unless the user manually changes the cell to a block.
   C. accepting and acknowledging the excess characters even though they may not be visible.
   D. automatically storing the excess characters in the adjacent cell.
   E. I am not sure

PART V: CBI Experience

Computer based instruction (CBI) is an educational tool that uses computers, computer programming, and human-computer interfacing to aid or conduct the education or training of people. For the purposes of this questionnaire, CBI software is any training or educational computer program that interactively engages in dialogue with the user for the purpose of training or educating. CBI can also be referred to as computer assisted instruction (CAI), computer assisted learning (CAL), computer based education, and many others. Some examples of CBI include interactive tutorial programs, simulations, or automated drill and practice (multiple choice question and answer) programs. Computerized entertainment programs (such as Nintendo or SEGA) are not considered CBI *unless the express purpose of the program* is to educate or train people.

1. Based on the above definition, have you used CBI?

   YES ____ NO ____ (IF NO, skip to PART VI)

2. When did you first use CBI?

   Year ________

3. Which of the following best describes your typical frequency of use of CBI?

   Very little ____
   Little ____
   A moderate amount ____
   Much ____
   Very much ____

4. Please describe the type of CBI you used? (Examples include software tutorials, simulations, automated question and answer programs, automated testing, etc.)

____

____

(Continue on reverse if necessary.)

5. Think a moment about your experience with CBI. How would you rate your CBI experience?

Completely Inexperienced |—+—+—+—+—+—| Highly Experienced

6. Have you ever written a computer based instruction program?

YES ____ (If YES, please describe below) NO ____

____

____

____

(Continue on reverse if necessary.)

PART VI: Completion Instructions

Thank you for taking the time to complete this questionnaire. Your input is important to AFIT and this research project. Your voluntary cooperation is invaluable to the success of this research. Please check the statement that applies to you:

_____ I would prefer to participate in this project as part of the computer based tutorial group.

_____ I would prefer to participate in this project as part of the in-class lecture group.

Appendix K: General Characteristics of the Student Groups

General Characteristics of the Student Groups Based on the Survey of the Incoming QMGT 290 Students

	All Students	% All	CBI Students	% CBI	In-class Students	% In
Had an education higher than a BS:	18	18%	10	22%	8	14%
Average years of government service:	10		10		10	
Owns a computer:	77	75%	35	76%	42	74%
Type: IBM:	66	64%	31	67%	35	61%
Other:	8	8%	1	2%	7	12%
Used a computer before arriving at AFIT:	100	97%	45	98%	55	97%
Had prior computer training:	70	68%	34	74%	36	63%
Wrote computer software:	33	32%	24	52%	9	16%
Used a spreadsheet program:	74	72%	35	76%	39	68%
Owned a spreadsheet program:	45	44%	22	48%	23	40%
Had prior spreadsheet training:	20	19%	5	11%	15	26%
Had ever used CBI:	68	66%	33	72%	35	61%
Had personally written CBI:	4	4%	2	4%	2	4%

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Vita

Captain Russell A. Greene was born on 27 August, 1960 in Spruce Pine, North Carolina. After graduating from Avery County High School, he earned his Bachelor of Science in Physics from Appalachian State University, in Boone, North Carolina. He was commissioned in the United States Army through the ROTC program in 1983. For his first four years of active duty he was assigned to the 782nd Maintenance Battalion of the 82nd Airborne Division, at Fort Bragg, North Carolina. Here he worked as a Missile Maintenance Platoon Leader, a Missile Maintenance Shop Officer, and a Battalion S4 (logistics) Officer. He spent his next three years as the Commander of the 521st Maintenance Company, located in Frankfurt, Germany. He was selected for attendance to the School of Systems and Logistics at the Air Force Institute of Technology under the Graduate Logistics Management program.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1991

3. REPORT TYPE AND DATES COVERED
Master's Thesis

4. TITLE AND SUBTITLE
AN EXPERIMENTAL STUDY IN THE USE OF COMPUTER-BASED INSTRUCTION TO TEACH AUTOMATED SPREADSHEET FUNCTIONS

5. FUNDING NUMBERS

6. AUTHOR(S)
Russell A. Greene, Captain, USA

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/LSR/91S-24

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
Educational institutions at all levels are increasingly examining the advantages of computer-based instruction (CBI) to augment or replace conventional classroom learning environments. This research measures the effectiveness and efficiency of a CBI program in relation to the same course content delivered in a conventional classroom mode of an undergraduate course that teaches students the basic concepts and techniques of automated (electronic) spreadsheets. A CBI program was created to "mirror" the in-class instructional material of the course. The performance of the students who took the course by CBI was compared to the performance of the students who took the class in the conventional mode. The CBI was found to be significantly more efficient while producing learning effects similar to the conventional mode of instruction. The students' prior experience and knowledge levels were offset by learning in either instructional mode. The initially "weaker" students were not identifiably weaker after completing the course by either mode. Self-reported prior experience was an effective indicator of the students' actual pre-course knowledge level, but not an indicator of the students' post-course performance.

14. SUBJECT TERMS
Computer-based Instruction, Computer-assisted Instruction, Programmed Instruction, Computer Applications, Teaching Methods, Man-computer Interface

15. NUMBER OF PAGES
104

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

AFIT Control Number AFIT/GLM/LSR/91S-24

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/LSC, Wright-Patterson AFB OH 45433-6583.

1. Did this research contribute to a current research project?

   a. Yes   b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes   b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Please estimate what this research would have cost in terms of manpower and/or dollars if it had been accomplished under contract or if it had been done in-house.

   Man Years ________________ $________________

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. Highly Significant   b. Significant   c. Slightly Significant   d. Of No Significance

5. Comments

________________________   ________________________
Name and Grade   Organization

________________________   ________________________
Position or Title   Address